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Amplitude and Phase Modulation With Waveguide Optics

S. C. Burkhart, R. Wilcox, F. Penko, D. Browning

Lawrence Livermore National Laboratory, L-490
P. O. Box 808, Livermore, Ca 94551
Phone: (510) 423-2061, FAX (510) 422-7748

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Scott C. Burkhart
P. O. Box 808, L-490
Livermore, Ca 94551
Phone: (510) 423-2061
Fax: (510) 422-7748

Russ B. Wilcox
P. O. Box 808, L-490
Livermore, Ca 94551
Phone: (510) 423-1343
Fax: (510) 422-7748

Frank A. Penko
P. O. Box 808, L-493
Livermore, CA 94551
Phone: (510) 422-3621
Fax: (510) 422-7748

Don F. Browning
P. O. Box 808, L-489
Livermore, Ca 94551
Phone: (510) 423-3015
Fax: (510) 422-7748

Abstract

We are developing amplitude and phase modulation systems for glass lasers using integrated electro-optic modulators and solid state high-speed electronics. The present and future generation of lasers for Inertial Confinement Fusion require laser beams with complex temporal and phase shaping. Previous to the Beamlet laser, this was accomplished using bulk electrooptic modulators, using high voltage electronics. On Beamlet[1] we demonstrated the use of fiber optics and waveguide electrooptic modulators to reduce the voltage requirements by three orders of magnitude. The key optical component for amplitude modulation is an integrated Mach-Zehnder interferometer on $LiNbO_3$ substrates, with a 6 GHz bandwidth and a 5V half wave voltage. A similar device, without the interferometer, is used for phase modulation.

Temporal pulse-shaping is performed using an arbitrary electrical waveform generator (AWG) which we recently developed. The requirements for NIF are a pulse 20 ns long, shaped to a contrast of 500:1, with a frequency content to 1 Ghz. We have achieved these results with a design capable of 7 ns pulse lengths, and have generated a limited number of the NIF pulse shapes by combining the AWG with a square pulse generator. Designed using high-power microwave transistors (GaAs-FET's), the AWG performs with a contrast and bandwidth beyond that commercially available. The electrical output from the AWG drives the integrated modulator, in conjunction with an automatic null biasing circuit. It was installed on Beamlet, and has been used there for nearly a year.

Phase modulation is performed with standard microwave equipment driving an integrated phase modulator. A 3 Ghz microwave oscillator is switched into an amplifier to provide up to 2 W in several microseconds to the phase modulator. The spectrum has been measured, showing near textbook performance. Our system includes several safety features to disconnect the microwave power under conditions which would damage the electrooptic modulator.

We will present the design and show the performance of these systems in detail.

1. J. H. Campbell et. al., "Special Issue: Beamlet Laser Project," *ICF Quarterly Report* 5(1), pp. 42-44, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-LR-105821-95-1 (1995).

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